Journal of Pediatric Surgery 57 (2022) 736–739

Contents lists available at ScienceDirect

Journal of Pediatric Surgery

journal homepage: www.elsevier.com/locate/jpedsurg.org

Controlled long term outcome of pyloromyotomy for pyloric stenosis: No long-term adverse effect

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ARTICLE INFO

Article history:
Received 23 November 2021
Revised 29 March 2022
Accepted 12 April 2022

Keywords:
Pyloric stenosis
Pyloromyotomy
Long-term outcome

ABSTRACT

Purpose: Pyloromyotomy for pyloric stenosis is one of the more common surgical procedures performed on infants. The long-term effects of the procedure are however unclear. The purpose of this study was to study the effects into adult life, compare them with controls and to see if there is a need for structured follow up of patients.

Methods: Of the 101 patients operated for pyloric stenosis between 1972 and 1974 at our tertiary referral center 91 could be traced. They were all invited to participate in the study and were sent validated questionnaires (PAGI-SYM, GIQLI) as well as a study-specific questionnaire examining the use of antacid drugs, incidence of gastroscopy and abdominal surgery. Sixty patients responded (66%, mean age 45 years, 46 male) and were included. Thereafter, 600 age and sex-matched controls were sent the same questionnaires. 132 responded (22%, 90 male) and were includes as controls.

Results: No significant differences could be found in any of the examined parameters when looking at the whole material or the male patients. Female patients had higher PAGI-SYM-scores for post prandial fullness (mean 1.11 vs 0.43, $P = 0.035$) and heartburn (mean 0.59 vs 0.14, $P = 0.043$) when compared to controls.

Conclusions: The present study shows that most patients operated for pyloric stenosis during infancy experience no negative effects into adulthood. The finding in the female patient group is interesting but is unlikely to have any clinical implications.

The results from this study strongly implicate that there is no need for follow up of patients into adulthood.

Level of evidence: Level III.

1. Introduction

1.1. Background

Infantile hypertrophic pyloric stenosis (IHPS) has been reported to affect up to 1/500 children and usually develops between 2 and 12 weeks after birth [1,2]. IHPS is four times more likely to affect male children [3]. The risk of developing IHPS is increased with premature birth, being firstborn, young parents and low educational level of the mother [1,4]. Association with some genetic factors have been described [5,6] but in most cases the reason remains unknown. Surgical treatment of IHPS is the most common praxis but treatment with intravenous and/or oral atropine can be used. Conservative treatment requires longer hospital stay and has a lower chance of success (80–89%) compared to surgical treatment [7,8]. It can however be a good alternative in children where anesthesia is contraindicated or unavailable.

The most common procedure to surgically treat IHPS, pyloromyotomy, was originally described by Ramstedt in 1912. The same procedure is utilized in many parts of the world even if a laparoscopic approach can be used.

Even though pyloromyotomy has been the standard of care for many years few studies of the long-term effects of surgery have been done. Follow up during infancy has indicated a higher risk of developing chronic abdominal pain [9]. Follow up into adulthood has been done but without controls which makes the interpretation of data difficult [10–14].

Abbreviations: IHPS, infantile hypertrophic pyloric stenosis; GI, gastrointestinal.

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https://doi.org/10.1016/j.jpedsurg.2022.04.005

1.2. Aims of study

The primary aim of this study was to evaluate the long-term outcome of surgical treatment of IHPS and correlate the results to age and sex-matched controls. The secondary aim was to see if there was indication for development of standardized follow up of these patients.

2. Methods

2.1. Patients

During the period 1972–1974 all patients operated for IHPS at a tertiary referral center (the department of Pediatric Surgery, Akademiska sjukhuset, Uppsala, Sweden) were prospectively identified by the last author (GL). All patients were operated with a classical open pyloromyotomy through a right upper quadrant incision. 101 patients were operated on during the time span. In 2018, 91of the 101 patients could be tracked and were invited to participate in the study by mail (including the questionnaires described below). 60 patients (66%) accepted the invitation and were included in the study. The demographic data for the included patients and the patients who declined participation is presented in Table 1.

2.2. Controls

When the included cohort of 60 patients had been identified 600 age and sex-matched persons were identified using the National Swedish Population Register. The number of persons were selected with the calculation that around 20% would respond and that we wanted two controls per patient. The 600 persons were sent the questionnaires and were invited to participate by mail. 132 persons (22%) returned the questionnaires and were included as a control group. The control group included 90 males and 42 women. This meant that each male patient had 1.96 controls and each female patient hade 3 controls. We chose to retain the higher number of female controls since the female group was smaller. None of the controls had undergone surgery during the neonatal period. The demographics of the control group and the persons who did not return the questionnaires is presented in Table 2.

2.3. Questionnaires

The questionnaire material sent to the patients included three questionnaires: 1. The validated PAGI-SYM questionnaire [15] to assess symptoms from the upper gastrointestinal tract. 2. The validated GIQLI questionnaire [16] to assess quality of life related to gastrointestinal function. 3. A questionnaire designed solely for this study which complements the data collected from the other questionnaires.

The PAGI-SYM questionnaire contains 20 questions and gives six subscales: Nausea/vomiting, post prandial fullness, bloating, upper abdominal pain, lower abdominal pain and heartburn. These are graded from 0 to 5 where 0 means no symptoms and 5 means very severe symptoms.

The GIQLI questionnaire contains 30 questions and gives four subscales: Symptoms, emotion, physical function and social function. These are graded from 0 to 4 where 0 means no symptoms and 4 means very severe symptoms.

The questionnaire designed for this study contained questions giving the following data: Weight, length, occupation, level of employment/current studies/unemployment, level of education (graded 1–8 where 1= basic school and 8= PhD), diseases that they were treated for, if they have seen a doctor during the last 2 years for upper gastrointestinal problems, current use of antacid drugs, if they had undergone gastroscopy or X-rays of the upper GI-tract and if they had undergone gastrointestinal surgery.

Since the questionnaire-material was quite extensive both the patients and the controls were offered a token incentive for their participation. This was lottery tickets with a value of 60SKR (equivalent of approximately €6).

Table 1
Demographic data of patients included and the patients who declined participation in the study.

	Included patients	Declined participation
Number	60	31
Male/female	46/14	25/6
% females	23.3%	19.3%
Age (mean)	45.2 years	44.8 years

Table 2
Demographic data of the control group as well as the persons that declined invitation as controls.

	Included in control group	Declined participation
Number	132	469
Male/female	90/42	371/98
% females	32%	21%
Age (mean)	45.1 years	44.9 years

2.4. Statistical methods

Values are presented as proportions, means and range where appropriate. Fishers two tailed exact-test was used to compare proportions. Mann Whitney U-test was used for comparisons between groups. A *P*-value below 0.05 was considered statistically significant. Statistica 13 software (TIBCO, Palo Alto, California, USA) was used for statistical analysis.

2.5. Ethical approval

The study was approved by the Regional Ethical Review Board (Dnr. 2017/415). All patients and controls provided written informed consent.

3. Results

3.1. Demographics

There were no statistically significant differences in height, weight or educational level between patients or controls. There were however significant differences when it came to unemployment and sickness benefits. Sickness benefits in Sweden is paid to persons who are unable to work because of medical reasons. Unemployment was more common in the male control group and receival of sickness benefits was more common in the female patient group. All patients receiving sickness benefits did this because of neuropsychiatric reasons. Data is presented in Table 3.

3.2. Medications, examinations and operations of the upper intestinal tract

It was more common that the control patients (both when looking at the whole material, males and females) used antacid drugs, had undergone a gastroscopy or an X-ray of the upper GI-tract. There were however no statistically significant differences between patients and controls. Data is presented in Table 4.

Table 3
Demographic data. *P*-values are presented under the controls. Significant *P*-values are marked in bold font and with an *.

	All Patients	All Controls	Male Patients	Male Controls	Female Patients	Female Controls
Height (cm)	176.7	176,7 ($P = 0.836$)	180.2	181,5 ($P = 0.584$))	165.4	166.5 ($P = 0.373$)
Weight (kg)	85,4	81,8 ($P = 0.164$)	88.5	89.8 ($P = 0.551$)	71.1	68.1 ($P = 0.874$)
Education level (1–8)	4.5	4.8 ($P = 0.244$)	4.3	4.7 ($P = 0.200$)	5.1	5.0 ($P = 0.859$)
Unemployed (n)	0	3 (***P = 0.030****)	0	3 (***P = 0.038****)	0	0 ($P = N/A$)
Sickness benefit (n)	3	0 (***P = 0.030****)	0	0 ($P = N/A$)	3	0 (***P = 0.013****)

Table 4
Data on medications and procedures performed on the upper GI-tract in adulthood. *P*-values are presented under the controls.

	All patients ($n = 60$)	All controls ($n = 131$)	Male patient ($n = 46$)	Male controls ($n = 90$)	Female patients ($n = 14$)	Female controls ($n = 42$)
Use of antacid drugs (n (%))	7 (11.7%)	27 (20.6%) ($P = 0.058$)	5 (10.9%)	16 (17.8%) ($P = 0.329$)	2 (14.2%)	11 (26.2%) ($P = 0.480$)
Gastroscopy	7 (11.7%)	25 (19.1%) ($P = 0.296$)	5 (10.9%)	16 (17.8%) ($P = 0.329$)	2 (14.2%)	9 (21.4%) ($P = 0.076$)
X-ray of upper GI	2 (3.3%)	7 (5.3%) ($P = 0.723$)	2 (4.4%)	7 (7.8%) ($P = 0.718$)	0 (0%)	0 (0%) ($P = N/A$)
Surgery of upper GI	3 (5%)	5 (3.8%) ($P = 0.707$)	2 (4.4%)	4 (4.4%) ($P = 1.000$)	1 (7.1%)	1 (2.4%) ($P = 0.441$)

Table 5
Mean values of PAGI-SYM domains, values can range from 0 to 5 where 0 means 0 symptoms and 5 maximal symptoms. *P*-values are presented under the controls. Significant *P*-values are marked in bold font and with an *.

	All patients ($n = 60$)	All controls ($n = 131$)	Male patient ($n = 46$)	Male controls ($n = 90$)	Female patients ($n = 14$)	Female controls ($n = 42$)
Nausea/vomiting	0.13	0.08 ($P = 0.765$)	0.07	0.06 ($P = 0.489$)	0.31	0.10 ($P = 0.394$)
Post prandial fullness	0.57	0.46 ($P = 0.691$)	0.40	0.47 ($P = 0.565$)	1.11	0.43 (***P = 0.035****)
Bloating	0.88	0.58 ($P = 0.198$)	0.64	0.42 ($P = 0.080$)	1.67	0.90 ($P = 0.240$)
Upper abdominal pain	0.48	0.29 ($P = 0.208$)	0.39	0.24 ($P = 0.540$)	0.79	0.39 ($P = 0.404$)
Lower abdominal pain	0.40	0.30 ($P = 0.622$)	0.30	0.15 ($P = 0.600$)	0.71	0.62 ($P = 0.933$)
Heartburn	0.38	0.24 ($P = 0.334$)	0.31	0.24 ($P = 0.815$)	0.59	0.14 (***P = 0.043****)

Table 6
Mean values of GIQLI domains, values can range from 0 to 4 where 0 means 0 symptoms and 4 maximal symptoms. *P*-values are presented under the controls.

	All patients ($n = 60$)	All controls ($n = 131$)	Male patient ($n = 46$)	Male controls ($n = 90$)	Female patients ($n = 14$)	Female controls ($n = 42$)
Symptoms	0.80	0.65 ($P = 0.415$)	0.71	0.59 ($P = 0.645$)	1.1	0.77 ($P = 0.184$)
Emotion	1.45	1.37 ($P = 0.474$)	1.42	1.36 ($P = 0.744$)	1.52	1.39 ($P = 0.373$)
Physical function	0.94	0.79 ($P = 0.732$)	0.82	0.71 ($P = 0.932$)	1.33	0.94 ($P = 0.394$)

3.3. PAGI-SYM

There were no statistical differences in any of the domains of the PAGI-SYM-questionnaire when looking at the whole material or the male patients and their corresponding controls. There was however statistically significant difference in two domains when looking at the female patients: Post prandial fullness ($P = 0.035$) and Heartburn ($P = 0.043$). Data is presented in Table 5.

3.4. GIQLI

There were no statistical differences in any of the three GIQLI-domains when comparing the whole material, males and females. Data is presented in Table 6.

4. Discussion

It is well established that the short-term outcome of pyloromyotomy is excellent with immediate relief of the gastric outlet obstruction with few complications [7]. However, long-term outcome following surgical treatment of pyloric stenosis is less studied. Our present study shows that the majority of patients at follow up 44–46 years after pyloromyotomy experienced no or few negative GI-related symptoms. There has been concern of a permanently impaired pyloric sphincter function following pyloromyotomy that could result in duodenal reflux or abnormal gastric emptying rate. Tam et al. reported significantly increased duodenal reflux at rest and faster gastric emptying in IHPS patients compared to controls five to eleven years following pyloromyotomy [17]. However, results from physiological studies of pyloric function after pyloromyotomy are scattered, both Sun et al. and Rasmussen et al. demonstrated normal values of gastric emptying in IHPS patients in long term follow up after pyloromyotomy [18,19]. Bile reflux is associated to gastritis, gastric ulcer and possibly also development of gastric cancer [20]. At a rapid gastric emptying rate, the duodenal mucosa is exposed to a high acid load predisposing for duodenal ulcer [21]. Given this, an increased prevalence of dyspepsia and ulcers would be expected in the long-term course after pyloromyotomy if the procedure resulted in a disrupted pyloric sphincter mechanism. The few previously performed long-term follow up studies on this topic have all, to some extent, reported patients who experienced dyspeptic symptoms or had a history of gastric or

duodenal ulcer [10–14]. However, since no controls were included in these studies it is difficult to interpret if the prevalence was higher among the patients compared to the general population. In our material it was even more common that the controls had undergone gastroscopy or used antacid mediciation than the patients, although the difference was not significant. It is therefore unlikely that IHPS results in an increased risk of dyspeptic symptoms in the long-term.

In our subanalysis stratified on gender, the female patients reported significantly higher PAGI-SYM scores in the domains post prandial fullness and heartburn compared to their controls. The difference in mean score was however small (0.68 points for post prandial fullness and 0.45 points for heartburn). Clinically valid differences for PAGI-SYM has been suggest to be in the range 0.21–1.28 [22]. Taking this in account combined with the finding that fewer female patients had undergone a gastroscopy and were using less antacid drugs the findings are probably not clinically significant. Also, three of the females in the IHPS group received sickness benefits because of neuropsychiatric disorders which could affect the results.

As all studies this one has its strengths and weaknesses. Its primary strength is the length of follow up and that it has a study design with a matched control group. Its weaknesses are however several: As a study based on questionnaires there is the risk of recall bias. We tried to minimize this risk by limiting the questions regarding symptoms to include the two past years. It is has a response rate of patients of 66% but only 22% of the controls which of course is suboptimal. These response rates are unfortunately the ones a clinical researcher often encounter [23]. Nevertheless, it raises the question: Which patients and which controls answer the questionnaires? Do we attract responders with more symptoms? Given the results of the present study and that the demographics of the controls and patients did not differ this is unlikely. According to the Swedish National Statistics Bureau, SCB, the unemployment rate in Sweden for persons aged 40 was around 6, 7% during the time the questionnaires were distributed.We had three unemployed persons in the control group (2.4% total, 3.3% of males) which is not an overrepresentation. Hence we can be sure that the incentive of lottery tickets did not entice unemployed persons to respond.

5. Conclusion

The present study shows that most patients operated for pyloric stenosis during infancy experience no negative effects into adulthood. The finding in the female patient group is interesting but is unlikely to have any clinical implications. The results from this study strongly implicate that there is no need for follow up of patients into adulthood.

Level of evidence

Level III.

Declaration of Competing Interest

None of the authors have any financial interests in the study

Acknowledgments

The study was supported by unconditional grants from Gillbergska Stiftelsen (Uppsala, Sweden), Sahlénstiftelsen (Stockholm, Sweden) and Ingrid och Thurings stiftelse (Stockholm, Sweden).

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jpedsurg.2022.04.005.

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